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ABSTRACT

This study investigates the cognitive and linguistic aspects of the concept of time which is assumed to consist of the components of order (O), simultaneity (S), and duration (D) as well as their coordination, i.e., coordination of order and duration (OD), and coordination of simultaneity and duration (SD). It was hypothesized that each component (O,S,D) is acquired separately before it is combined with any other component (OD,SD). An acquisition sequence of the three components (O,S,D) was also sought. Forty-five 4-, 5- and 6-year-old children were tested individually. Three behavioral outputs (body movements, manipulation of lights and language) were included. Each child was given four tasks: nonverbal imitation, production, comprehension, and verbal imitation. The indicators used for order were before/after, first/last; for simultaneity, when, at the same time; for duration, a long time/a short time; for coordination of order and duration, until; coordination of simultaneity and duration, while, during. The results support the following developmental sequence for the concept of time. First, the main components (O,S,D) are understood separately (possibly in that order), then they are integrated (OD,SD). Moreover, temporal relations are grasped first on a nonverbal level and later on a linguistic level. (Author/SB)

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THE DEVELOPMENT OF THE CONCEPT OF TIME*

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This study investigates the development of the conceptual and linguistic aspects of the concept of time. In agreement with Piaget, we assume that the concept of time consists of the components of order of events, simultaneity of events, and duration of events as well as their integration into coordination of order and duration, and coordination of simultaneity and duration. This will be explained in detail shortly. Prior work in this area has been fragmentary in that no one other than Piaget has looked at the three components and their coordinations. However, Piaget does not consider linguistic aspects of the development of the concept of time.

We hypothesized that each component, order, simultaneity, and duration, is acquired separately before it is combined with any other component. We were also interested in whether or not the three components are acquired in a specific sequence.

Forty-five children of the ages 4, 5, and 6 and 7 adults were tested individually. They were given four tasks. The components and their coordinations were examined independently of each other across the same four tasks. The items were completely randomized within each task. The adults determined the ultimate obtainable level of performance on each task.

Slide #1

Three behavioral modes are included in the experiment; body movements, manipulation of lights and language. Body movements, for example, are pinch cheek, or raise arm. For lights, a red or green light is turned on by pushing a red or green button. For language sentences are used. These three modes are used for input to the subject by the experimenter and for the output

requested from the subject. The slide shows how these modes are combined with each other to form the four tasks, with Nonverbal Imitation, Production, Comprehension, Verbal Imitation given to the child in that order.

The Nonverbal Imitation task is assumed to test the conceptual, nonlinguistic aspects of the concept of time. The input by the experimenter is either Body Movements or Lights, and the requested output is the child's imitation of the same. For example, for the component of order, the experimenter pushes the red button, then the green button; for simultaneity, she pushes the red and the green at the same time; for duration, she pushes the red for a long time; for coordination of order and duration, she pushes the red for a long time, then pushes the green for a short time; for coordination of simultaneity and duration, she pushes the red and the green at the same time for a long time.

For the Linguistic Production task, the input is either Body Movements or Lights, and the output is Language. For example, the experimenter pushes the green then the red, and the child is required to describe what the experimenter has acted out. The experimenter's input actions are exactly the same as those used in the Nonverbal Imitation task.

For the Linguistic Comprehension task, the input is Language, and the output is either Body Movements, Lights, or Language. The child is asked to act out sentences read to him. The sentences describe temporal relations of Body Movements or Lights. For example "Push the green before you push the red". In addition, the child is asked to answer questions about the temporal relations of

events in stories. For example, he is shown 5 drawings telling a sequence of events in a zoo, and is asked, "What does the girl do before she watches the lions?"

For the Verbal Imitation task, the input is Language and the output is Language. The child is required to repeat sentences read to him. The sentences include temporal terms for each component and coordination. For example, "The girl watches the lions before she runs."

In the Comprehension and Verbal Imitation tasks, the component of order is examined with the words before/after, first/last; simultaneity with the words when, at the same time; duration with a long time, a short time; coordination of order and duration with until; coordination of simultaneity and duration with while, during. The present tense is used for all components and coordinations in the Comprehension and Verbal Imitation tasks.

Results

Slide #2

This slide shows the three main effects. It shows total percent correct for each component and coordination, each task, and each age group.

For the components and their coordinations, the results support the hypothesis that each component is acquired separately before their coordinations. For example Order (72%) and Duration (69%) are significantly higher than Order & duration (38%). And Simultaneity (68%) and Duration (69%) are significantly higher than Simultaneity & duration (52%).

For the tasks, there is a significant order of task difficulty, with percent correct being the highest for the Nonverbal Imitation

task, followed by the Verbal Imitation task, Comprehension task, and Production task. Each task is significantly different from each of the others.

The three age groups show a significant developmental trend. Percent correct is lowest for the four-year-olds, and highest for the six-year-olds.

Slide #3

Here the same data is presented as percent correct broken down for each component and coordination, for each task, and for each age group. The hypothesis that each component is acquired separately before their coordinations is supported by each age group and each task. For example, in the Nonverbal Imitation task for the 4-year-olds, 88, 90, 79 are higher than 47 and 42.

The order of task difficulty with Nonverbal Imitation being the easiest followed by Verbal Imitation, Comprehension, and Production, in that order, is true for all age groups. For example, for the 4-year-olds, 69, 65, 60, 8. The consistent order of task difficulty suggests that temporal relations are acquired on a nonlinguistic, conceptual level first, and later on a linguistic level.

The developmental trend between the age groups is present for each task except the Production task. For example, for the Nonverbal Imitation task, 69, 85, 96. In fact, this developmental trend appears for most of the components and coordinations for all the tasks but the Production task. For example, in the Nonverbal Imitation task, for coordination of order & duration, 47, 72, 92.

When percent correct is considered, there appears to be no strong acquisition sequence for the components of order, simultaneity, and duration. However, the analysis of errors reveals substitutions which suggest an acquisition sequence with order being the easiest and duration the hardest. Examples of substitution errors are: In the Nonverbal Imitation task, the experimenter pushes the red and the green at the same time, and the child responds by pushing the red then the green. In the Verbal Imitation task, the experimenter says "The boy swings until he buys a balloon", and the child's response is "The boy swings after he buys a balloon." In the Comprehension task, the experimenter says "Push the red and the green at the same time" and the child pushes the red then the green.

Slide #4

The slide shows the total number of substitution errors over all the ages and over all the tasks except the Production task which had very few substitution errors. Order responses were substituted for simultaneity, duration, order & duration, simultaneity & duration most of the time with 609 out of a total of 807 substitution errors. This was followed by simultaneity substitutions with 170 out of 807, followed by very few other substitutions. This general trend is apparent for each task separately. This suggests that although the components of order, simultaneity, and duration in terms of percent correct appear to be acquired at the same time, substitution errors seem to indicate an order of difficulty with order being the easiest and duration being the most difficult.

Slide #3

A possible reason for not observing in this study, an acquisition sequence for the components of order, simultaneity, and duration might have been that the children are already correctly identifying the three components. The percent correct for the components in the first three tasks is high for all ages. For example, in the Nonverbal Imitation task, for the 4-year-olds, 88, 90, 79. With younger subjects an acquisition sequence of the components might have been observed, as appears to have occurred on the more difficult Production task here. For example, for the 4-year-olds, 20, 9, 5.

Conclusion

In conclusion, in this study of the concept of time, the conceptual and linguistic development of the same components and their coordinations was followed with the same children, permitting a direct comparison of their conceptual and linguistic development. The results support a similar developmental sequence for the conceptual and linguistic aspects of the concept of time. First, the main components order, simultaneity, duration are grasped separately (possibly in that order) then they are integrated. Moreover, temporal relations are understood first on a nonverbal or conceptual level and later, on a linguistic level.

SLIDE #1

Tasks Categorized by Experimenter's Input and Child's Output

INPUT	OUTPUT		
	Body Movements	Lights	Language
Body Movements	nonverbal imitation		production
Lights		nonverbal imitation	production
Language	comprehen-sion	comprehen-sion	(1)verbal imitation (2)comprehension

SLIDE #2

Total Percent Correct for the Components and their Coordinations, Tasks, or Ages

COMPONENTS & COORDINATION		TASK		AGE (yrs)	
order	72	nonverbal imitation	83	four	50
simulta-neity	68	verbal imitation	76	five	59
duration	69	comprehen-sion	70	six	70
ord & dur	38				
sim & dur	52	production	9		

SLIDE # 3

Percent Correct

TASK	AGE	COMPONENTS			COORDINATIONS		TOTAL
		ord	sim	dur	ord & dur	sim & dur	
nonverbal imitation	4	88	90	79	47	42	69
	5	98	96	93	72	65	85
	6	100	100	99	92	84	96
verbal imitation	4	77	70	86	27	58	65
	5	90	75	94	48	67	76
	6	94	89	100	81	82	90
comprehension	4	74	73	73	23	58	60
	5	86	84	85	23	67	69
	6	95	98	94	25	90	81
production	4	20	9	5	4	1	8
	5	15	13	4	2	3	7
	6	22	16	13	7	5	13

SLIDE #4

Number of Substitution Errors of Components and their Coordinations for all Ages and Tasks except the Production Task

INPUT BY E	ERROR OUTPUT					
	ord	sim	dur	ord & dur	sim & dur	Total
ord	---	12	1	3	0	16
sim	118	---	1	0	4	123
dur	27	1	---	0	0	28
ord & dur	274	91	0	---	2	367
sim & dur	190	66	8	9	---	273
Total	609	170	10	12	6	807